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THE MORTALITY, BEHAVIOR, AND HOMING OF TRANSPLANTED JUVENILE CANADA GEESE[1]

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Abstract: During the summers of 1967 and 1968, 273 flightless 7- and 8-week-old Canada geese (*Branta canadensis maxima*) were transplanted about 100 miles from their natal lakes near Brooks, to release sites northeast of Hanna, Alberta. All transplants received leg bands and colored neck collars for field identification. A preflight mortality of 4 percent was calculated. Postflight locations, identity, and behavior of transplants were recorded. Feeding was the major daily preflight activity of transplants, and occurred most intensively at sunrise and sunset. Resident geese were dominant over transplants. Non-breeding resident geese were more tolerant of transplants than were breeding pairs. The postflight movements of transplants were localized and as a unit under the leadership of resident birds. Transplants on release sites unoccupied by resident geese dispersed from these lakes in small groups immediately after obtaining flight. From 68 birds of each sex (136) transplanted in 1967, 13 homing female yearlings were recorded in the spring of 1968. In the spring of 1969, 22 females and 22 males were observed on the area from a potential of 61 males and 73 females transplanted the previous summer. Homing of yearling females was significantly ($P < 0.03$) higher than for yearling males. Eighty-five and 86 percent of the initial sightings of yearling females in 1968 and 1969 respectively, were on or within 1 mile of their release sites. In 1969, 32 percent of the initial sightings of yearling males were on or within 1 mile of their release sites. Eighty percent of the homing yearling females formed pair relationships during 1968 and 1969, with 68 percent occurring on the study area. Females appeared attracted to their release sites whether they were paired or unpaired. Sixty-eight percent of the yearling males showed pairing tendencies in 1969. Twenty-seven percent of these pair associations occurred on the study area. Of the yearling males returning, only those forming pair associations remained on the study area for 30 days or longer. Apparently the males were more attracted to the females in the pair associations than to their release sites. The pair bonds of some of the yearling females appeared to become unstable just prior to the summer molt migration. No 2-year-old males were known to home to the area. Five 2-year-old females homed to and paired on their release sites. One 2-year-old female nested and successfully raised a brood of 5 goslings.

The natural dispersion of large Canada geese throughout their original breeding range, as delineated by Hanson (1965), can best be described as slow, even under optimum habitat conditions. This lack of pioneering may be due to certain physiological and behavioral characteristics. Mayr (1942) stated that strong intrafamily bonds played an important role in the subspeciation of Canada geese over areas where geographic barriers were lacking. With reference to geese in general, Johnsgard (1965) attributed slow increase in numbers and lack of gene mixing to delayed maturation and permanency of pair bonds respectively. Sherwood (1967) confirmed the formation of both pair and intrafamily bonds. He also found a lack of dispersion from the natal area, particularly by females.

Because Canada geese are important for their aesthetic and sporting qualities, biologists have attempted to artificially establish local breeding populations by using captive flocks or by transporting and releasing juveniles. These attempts have produced variable results. Pirnie (1938) concluded that the restocking of Canada geese by captive flocks was successful in southern Michigan. Williams and Kalm-

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bach (1943:167) studied leg-band recoveries of both captive and transplanted juvenile Canada geese and stated, ". . . they show no tendency to return to the area from which they came." A steady increase in the production of wild goslings at Seney Refuge from 1934 to 1943 was attributed by Johnson (1947:23) to the development of a local breeding population from a captive flock. In assessing the use of captive flocks for the restoration of Canada geese, Nelson (1963) suggested that quantitative evidence relating to the positive and negative results of such programs was lacking. He recommended that intensive research be conducted to assess future restoration projects.

The purpose of this study was to quantitatively assess the mortality, behavior, and homing of juvenile geese that had been transported by artificial means from their natal area to some distant point and released.

The periods spent in the field during this study were as follows: 1967, early June through early September; 1968, late March through early September; 1969, late March through May.

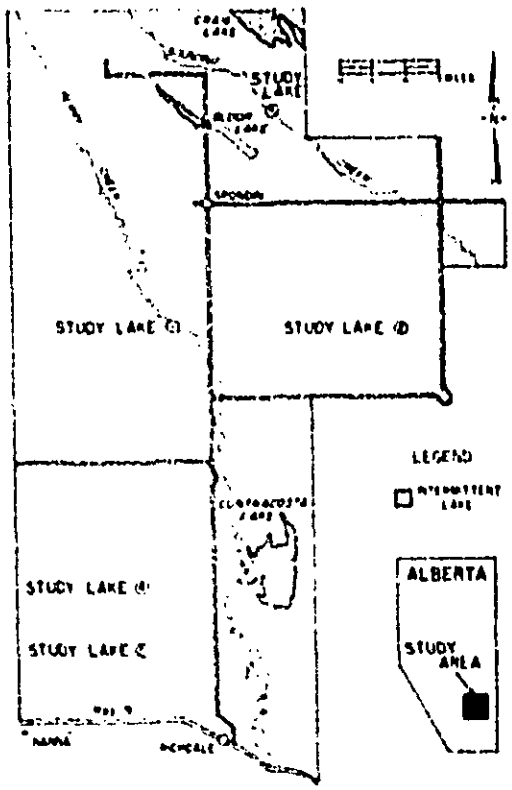

Fig. 1. The study area and location of study lakes in southeastern Alberta.

I wish to express my gratitude to the following for their contributions to this study: R. L. Eng, Montana State University, for technical supervision and guidance in preparation of the manuscript; W. Wishart for initial project planning and field assistance; C. Lacy for field assistance and use of Ducks Unlimited banding records; O. Glimsdale and A. Paulsen for investigations and reports of local band recoveries; E. Ewaschuck for reports of neck-collared geese; personnel from Ducks Unlimited (Canada) and the Alberta Fish and Wildlife Division, for assistance in banding and transplant operations; and to my wife, Penny, for patience, encouragement, and assistance. The Alberta Government, Fish and Wildlife Division, provided me with a vehicle and financial support during the field work portion of the study.

DESCRIPTION OF THE STUDY AREA

The study area was located in southeastern Alberta within 30 miles of the Town of Hanna (Fig. 1). This region is of glacial origin (Wyatt 1938–1943) and is characterized topographically by gentle undulations interspersed with hills and creek drainages. Local land-use practices are primarily agricultural with the greatest emphasis on dryland grain farming and cattle ranching.

A complete and quantitative description of the vegetation found on the area is given by Coupland (1950). He described the vegetative cover as "mixed prairie" with the dominant grasses being spear grass (*Stipa comata*), porcupine grass (*Stipa spartea* var. *curtiseta*), and blue gramma (*Bouteloua gracilis*). Fringed sage (*Artemisia frigida*) is the most abundant forb, while snowberry (*Symphoricarpos occidentalis*) and rose (*Rosa* spp.) are the most common shrubs.

The climate of the area represents that typically found in north temperate continental regions and is classed as a cool, semiarid type (Coupland 1950). The mean average annual temperature is 36.4 F with monthly averages varying from 6.0 F in January to 64.3 F in July. The average annual precipitation is 14.54 inches. Climatic information was obtained from the Canadian Department of Transport Weather Offices at Edmonton and Coronation.

A lack of permanent natural water bodies throughout this region prompted Ducks Unlimited (Canada) to construct over 175 dams in the area since 1940 to provide stable habitat for waterfowl production.

METHODS

Lakes with resident breeding geese and those without were deliberately chosen. The lakes also satisfied these criteria: (1) a minimum flooded area of 50 acres, (2) the presence of potential goose-nesting habitat, (3) an abundant food supply in or near the water, and (4) accessibility to the observer.

Geese used for transplanting were trapped on impoundments about 100 miles south of the study area near Brooks, Alberta. The birds were aged and sexed using plumage and cloacal characteristics as summarized by Hanson (1962). Goslings were further aged to the nearest week from plumage descriptions presented by Yocom and Harris (1965). In addition to leg bands, all transplants received colored flexible plastic collars (Sherwood 1966) bearing letter-numeral combinations to permit field identification of individual geese. Sherwood found that goslings older than 7 weeks exhibited higher collar retention than goslings in younger age groups. Only flightless goslings between the ages of 7 and 8 weeks were used. The transplants were banded and crated at the trapping sites, and transported by motor vehicle to the study area where each cohort was released on a preassigned study lake in late afternoon or at night.

Throughout the study, all written accounts of goose behavior were continuous and calibrated to the nearest minute for quantitative analysis.

Specific observational techniques were used during the preflight period. All cohorts were observed from a concealed position during each day from 1 hour before sunrise to 1 hour after sunset. Observational periods were of unequal duration. They were rotated among the study lakes to obtain data on the daily behavior of each cohort. Preflight mortality was determined from transplant counts during the behavioral observations.

Data concerning activities of transplants from sunrise until 2 hours after sunrise, and from 2 hours before sunset to sunset, were analyzed in ½-hour intervals. The analysis of activities prior to sunrise, throughout the midday (from 2 hours after sunrise until 2 hours before sunset), and after sunset was determined by grouping the data obtained for each respective time period.

Transplant activities during the morning

Table 1. Study lake size, and the number, sex composition, and preflight mortality of goslings transplanted to the study lakes during the 1967 and 1968 study periods.

Year	Study Lake	Lake Size (acres)[a]	Shoreline Length (miles)[a]	Number of Transplants	Sex of Transplants		Number Lost	Percent Lost
					M	F		
1967	1[b]	228.5	5.7	43[c]	19	24	1	2
	2[b]	216.7	4.1	46	24	22	1	2
	3	91.5	3.1	47	25	22	6	13
			Subtotals	136	68	68		
1968	1[b]	above	above	41	21	20	0	0
	3	above	above	40	18	22	2	5
	4	52.0	3.9	33	11	22	1	3
	5[b]	176.5	5.1	23	14	9	1	4
			Subtotals	137	64	73		
			Total	273	132	141	12	4

[a] Information obtained from the Hanna office of Ducks Unlimited (Canada).
[b] Resident geese present.
[c] Three transplants, hatched 4 miles from Study Lake 1, were included in this group.

and evening were divided into three general categories: (1) feeding, (2) resting, and (3) preening, bathing, and/or drinking. The activities in category 3 were assessed as one general activity because they all *frequently occurred simultaneously* within a group. Midday activities were separated into four categories: (1) feeding, (2) resting on water, (3) resting on land, and (4) preening, bathing, and/or drinking.

Greater mobility of the observer was required to obtain postflight data. All accessible water bodies and fields within the boundary of the study area were checked daily for geese (Fig. 1). The location, identity, and behavior of all transplants were noted. Only during extended observations of postflight behavior did I attempt to remain concealed.

During the study, five Ducks Unlimited reservoirs were used as study lakes (Table 1). In 1967, 136 goslings comprised of 68 males and 68 females were transplanted to Study Lakes 1, 2, and 3. The 1968 transplants were placed on Study Lakes 1, 3, 4, and 5. This latter group totaled 137 goslings, 64 of which were males. Because of insecure water levels resulting from a lack of spring runoff in the area of Study Lake 2, this lake was not used in the 1968 transplant program.

RESULTS AND DISCUSSION

Preflight Period

Mortality.—One gosling died during transplant operations. Of 273 released, 261 or 96 percent survived to flight (Table 1). The preflight mortality varied on individual study lakes from 13 percent on Study Lake 3 in 1967 to no mortality on Study Lake 1 in 1968. Gosling counts made 3 days after the time of their release on three of the study lakes indicated that the major transplant losses occurred within 2 days following their release.

Coyotes (*Canis latrans*), long-tailed weasels (*Mustela frenata*), badgers (*Taxidea taxus*), striped skunks (*Mephitis mephitis*), marsh hawks (*Circus cyaneus*), and Swainson's hawks (*Buteo swainsoni*) were pres-

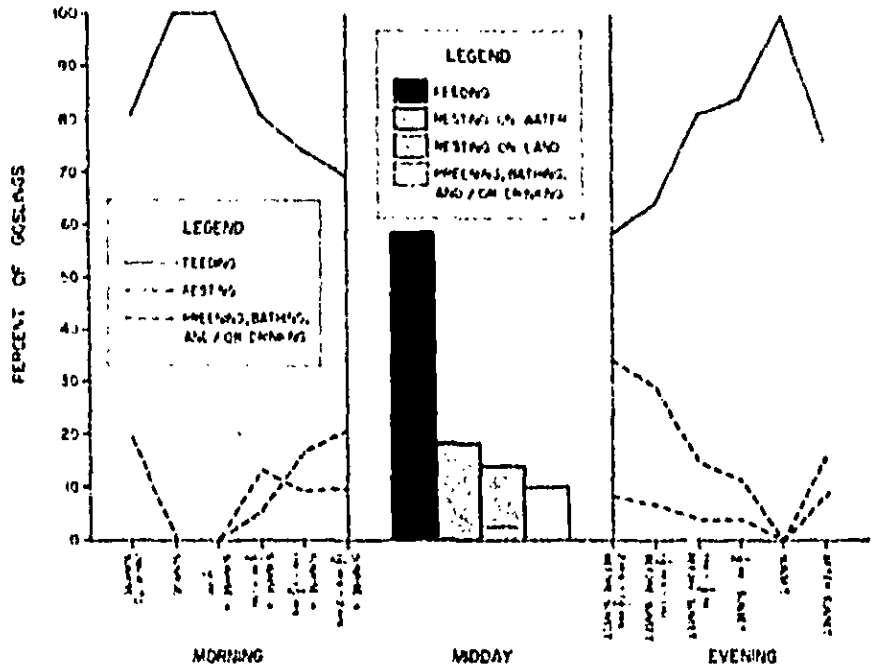

Fig. 2. Daily preflight activity of transplanted goslings.

ent on the study area. Eleven unsuccessful attempts by mammalian predators to capture transplants were observed. Goslings typically reacted to the presence of a predator by heeding alert warnings of other birds and moving offshore into secure water. Once on the water, the transplants became very curious about the intruder, usually following it as it traversed the shoreline.

Daily Activities.—Approximately 165 hours of observations on preflight activities were obtained. These activities and their relative magnitude throughout the daylight hours are graphically presented in Fig. 2.

Feeding was the major daily activity and showed a sharp increase from dawn until sunrise when 100 percent of the observed goslings were feeding intensively. Intensive feeding was maintained until a half hour after sunrise. A steady decline in feeding followed. At 2 hours after sunrise, 09 percent of the transplants were feeding. During the midday period, feeding comprised 58 percent of the gosling activity. Though feeding activity fluctuated throughout the midday period, at no time did its duration or intensity equal that observed in the morning or evening. Feeding activity increased steadily from 58 percent, 2 hours before sunset, to 100 percent at sunset. This was followed by a rapid decrease in feeding activity as darkness approached.

The tremendous energy requirements for growth and feather development by goslings (Hanson 1965, Williams 1967) is reflected in their daily activity. In my study, transplants from the age of 7 weeks until flight spent over 58 percent of their daytime activity feeding.

Throughout the daily observational peri-

ods, resting varied inversely with feeding activity (Fig. 2). Midday activity data show that 59 percent of the resting occurred on water. All early morning and late evening resting sites were on islands or low, narrow peninsulas. Williams (1967) reported the use of similar areas by resting Canada geese.

All intensive feeding periods were usually followed by drinking and preening activity. The duration of such activity varied directly with the duration and intensity of the feeding period preceding it. Bathing activity occurred more frequently during the midday period, particularly during hot weather. As darkness ensued and feeding activity declined, all transplants drank for a short time then preened extensively prior to their night rest period.

Social Behavior.—Among the transplants, males displayed a slightly higher dominance than did females. Fifty-three percent of 103 observations of dominance displays were by males. Williams (1967: 122) stated that, "Essentially the male controls the female . . . and older, bigger birds get the decisions over younger, smaller geese." Recent studies of Canada geese by Raveling (1966, 1967, 1969) have shown the dominant role of the gander in family and flock behavior. Both Hanson (1965) and Williams (1967) confirmed that males are normally slightly larger than females of equal age. Transplants of either sex that were obviously younger or smaller than the others assumed a subordinate role in all activities.

Resident adults and goslings were dominant over the transplants at all times. On many occasions resident goslings, regardless of age, were observed to dominate transplants. This confirms Hanson's (1965: 156) statement that, "The . . . immature separated from its family was clearly at the bottom of the peck order . . ." Boyd (1953) and Balham (1954) also observed these social relationships among geese.

Table 2. 1967 and 1968 fall movements.

Study Lake	Year	No. of Survivors on or Within 1 Mile of Home Lake After Transplant	No. of Survivors Over 1 Mile From Home Lake
Lake 1	1967*	9	0
	1968*	4	20
Lake 2	1967*	4	0
Lake 3	1967	0	1
	1968	1	1
Lake 4	1968	0	0
Lake 5	1968*	6	11

* Resident adults present on the study lake.

Varying degrees of tolerance to transplants were exhibited by adult geese on some of the study lakes. The breeding status of resident adults was influential in their behavior toward the transplants. A single, nonbreeding adult was observed to associate continuously with the transplants placed on Study Lake 5 in 1968. The nonbreeder joined the transplants immediately after they were placed on the lake. From this time on, it assumed the dominant role, showing leadership in all daily activities. The amount of tolerance exhibited by resident breeding pairs to the transplants appeared to be dependent on the age of the resident goslings. In general, more tolerance was displayed by resident adults whose goslings approached the age of the transplants. In wild or semi-wild populations of Canada geese, brood mixing commonly occurs as the goslings increase in age (Brakhage 1965). Adoption of these mixed broods is usually by the dominant pair in the brooding area (Sherwood 1967).

Postflight Period

Recoveries.—Twenty-eight direct recoveries of transplants were reported during

the 2-year study period. This included 21 recoveries from the hunting season of 1967 and 7 from the fall of 1968. Two indirect recoveries have been reported to date.

Behavior and Activities.—The presence of adults on study lakes had a noticeable effect on the movements and flock unity of transplants released on these lakes (*Table 2*). *The postflight movements of* transplants under the guidance of resident geese were more localized than those observed for transplants without adult leadership. Eighty-six percent of 63 fall postflight observations made during the 2-year period were of transplants from study lakes where resident adults were present. Forty-three percent of these sightings were of transplants on or within 1 mile of their release sites.

Although many transplants attained flight less than 1 week after their release, an attraction to the resident birds appeared to inhibit their early departure from these lakes. Initial movements of transplants away from these sites did not occur until the residents attained flight. At this time, all surviving transplants left these lakes as *a unit under the leadership of the resident* birds. From subsequent postflight sightings, it was apparent that this relationship between residents and transplants remained intact from late July, when initial movements were observed, until early September when my final observations were made.

It appeared that when transplants were placed on lakes occupied by resident geese, the resident adults were adopted as foster parents by the transplanted goslings. It also appeared that the dominance of the transplants as a unit, relative to other geese encountered in the area during their fall movements, was dependent on the social status of the adopted resident birds. For example, on three occasions during the fall of 1968, I observed the transplants from Study Lake 1 and Study Lake 5 field-feeding together, and on three other occasions I observed these same two groups feeding and loafing on Study Lake 5. Throughout all of these observations, the transplants from both lakes remained as distinctly separate units. The resident family leading *the transplants from* Study Lake 1 was comprised of a dominant pair with five goslings, whereas the transplants from Study Lake 5 were led by a single adult. *This difference in social standing* between the two flock leaders allowed the geese from Study Lake 1 to dominate those from Study Lake 5. Apparently the residents and transplants from Study Lake 1 were acting as one large family unit. This social order designating an adult pair with a family dominant over a single adult follows that described by Hanson (1965) and Williams (1967).

Of nine fall postflight observations made of transplants from lakes without resident adults present, only one was recorded within 1 mile of their release site. These data indicate that transplanted goslings placed on lakes uninhabited by resident geese dispersed from their release sites immediately after attaining flight.

Goslings released on lakes without resident birds showed little flock coherence. When goslings on such lakes became adept at flight, they immediately departed from their release sites.

Yearling Activities

Homing: Females.—During the spring of 1968, 210 sightings were made of 13 homing geese. All were females (Table 3), and were from a potential of 68 female goslings transplanted the previous summer. In the spring of 1969, 119 sightings of 22 homing females were made. The latter were from

Table 3 Sex and movements of homing yearling transplants during the springs of 1968 and 1969.

Release Site	Year	Sex	Number Observed	Total No. of Sightings on Study Area[a]	Sightings on or Within 1 Mi. of Home Lake[b]		Sightings Over 1 Mi. From Home Lake[b]	
					No.	Percent of Total Sightings	No.	Percent of Total Sightings
Lake 1	1968[b]	m	0					
		f	2	35	30	86	5	14
	1969[b]	m	10	35	9	26	26	74
		f	13	90	50	56	40	44
Lake 2	1968[b]	m	0					
		f	6	86	27	31	59	69
	1969	No 1968 transplants						
Lake 3	1968	m	0					
		f	5	89	27	30	62	70
	1969	m	4	13	0	0	13	100
		f	6	19	13	68	6	32
Lake 4	1968	No 1967 transplants						
	1969	m	1	2	0	0	2	100
		f	0					
Lake 5	1968	No 1967 transplants						
	1969[b]	m	7	19	5	20	14	74
		f	3	10	9	90	1	10

[a] Sightings of transplants from each release site were grouped for analysis.
[b] Lakes occupied by resident geese when transplants were released the previous year.

a potential of 73 females transplanted in 1968. Calculations in Table 4 indicate that theoretically, 43 and 71 percent of the surviving yearling females from the 1967 and 1968 transplants respectively, exhibited homing tendencies.

Eleven (85 percent) and 19 (86 percent) of the respective 1968 and 1969 initial sightings of the homing females were on or within 1 mile of the lake where they were released the previous year. With the exception of 2 females, later observations confirmed the movement of all homing females back to their home lakes. No marked transplants were sighted at the trapping sites in the Brooks, Alberta area (C. Lacy, personal communication) during the study period.

The spring water conditions on the study lakes apparently influenced the movements of the homing transplants relative to their release sites. Throughout the 1968 spring observational period, Study Lakes 2 and 3 lacked secure water areas while Study Lake 1 possessed a relatively large, secure body of water. Data presented in Table 3 show that 86 percent of all sightings of homing females from Study Lake 1 were on or within 1 mile of this lake. Only about 30 percent of all observations of transplants homing to Study Lakes 2 and 3, respectively, were recorded on or within 1 mile of these lakes. In the spring of 1969, an abundance of water was present on the study area. The attraction of temporary water areas to the homing females is reflected in the percent of sightings on or within 1 mile of the home lakes (Table 3). Females homing to Study Lake 1 were observed only 56 percent of the time

Table 4. Analysis of homing among yearling Canada geese.

Year	Sex	No. of Transplants	Theoretical Direct Recovery[a] (Percent)	Percent Neck Collar Loss[b]	Theoretical No. of Geese Surviving With Neck Collars	No. of Birds Homing	Calc. Percent of Collared Survivors Homing
1967	m	68	49	15	30	0	0
	f	68	49	15	30	13	43
1968	m	64	49	15	28	22	79
	f	73	49	15	31	22	71
				Total			
1967 and 1968	m	132	49	15	57	22	39
	f	141	49	15	61	35	58
					Chi-square = 4.36 ($P < 0.05$)[c]		

[a] Calculated average yearling kill in Brooks, Alberta area from Ducks Unlimited banding records of 1955 through 1965 inclusive (omitting 1957).
[b] Average neck collar loss reported by Sherwood (1966).
[c] Chi-square test calculated according to Steel and Torrie (1960). Chi-square value of 4.36 indicates males exhibit less homing than females ($df = 1$, $P < 0.05$).

($n = 90$) on or within 1 mile of this lake. Sixty-eight and 90 percent of the sightings of homing females from Study Lakes 3 and 5, respectively, were on or within 1 mile of their home lake. The latter percent may be questionable due to access difficulties which limited the number of observations on Study Lake 5 in the spring of 1969. No yearlings were known to home to Study Lake 4 in 1969.

The 1968 homing female transplants arrived on the study area over a 34-day period from March 23 to April 25, both dates inclusive (Fig. 3). In the spring of 1969, the initial arrival of homing females was 3 weeks later, the birds arriving over a period of 27 days, from April 10 to May 6 inclusive. When graphically illustrated in Fig. 3, these data show a greater number of initial sightings (69 percent in 1968 and 91 percent in 1969) during the first half of each respective time period, suggesting a more intensive yearling movement at this time.

The late arrival of yearling females in the spring of 1969 was probably due to persistent and severe winter weather conditions. Although the initial 1969 arrival was later than that of 1968, the intensity of movement was greater in the spring of 1969; 86 percent of the yearling females arrived within the first 10 days following the initial sighting. Only 31 percent of the yearling females arrived within the same time period in 1968.

Homing: Males.—Of 68 males transplanted in 1967, none were known to home to the study area in the spring of 1968. A single observation of one male was recorded in the late spring of 1968 as it passed through the study area with a group of unmarked geese apparently on a northward molt migration (Sterling and Dzubin 1967). Because of its time of arrival and length of stay on the area, the presence of this bird appeared due to chance rather than to a homing urge so I did not consider it a homing bird.

During the spring of 1969, 69 sightings of 22 homing males were made on the study area. This represented a calculated theoretical homing rate of 79 percent for the 64 males transplanted the previous summer (Table 4). Seven (32 percent) of

the 1969 initial male sightings were on or within 1 mile of their home lakes.

Yearling males spent less time on or near their home lakes than did the yearling females. Data in Table 3 show that yearling males spent from 0 percent (Study Lakes 3 and 4) to a maximum of 26 percent (Study Lakes 1 and 5) of their time on or near their home lake while on the study area.

The 1969 spring arrival times of yearling males on the study area were similar to those described for females during the same time period. Yearling males arrived over a 23-day period from April 10 to May 2 inclusive, with 90 percent of all observed males arriving during the first 10 days of this period (Fig. 3).

A number of observations of two yearling males were recorded at Dowling Lake, located approximately 25 miles west of the study area (E. Ewaschuck, personal communication).

The fact that no yearling males homed to the study area in 1968 can probably be attributed to their homing behavior rather than to any sex-specific mortality of the 1967 transplanted goslings. Two males from the 1967 cohort were present within 60 miles of the study area in 1969, indicating that these birds were present in 1968 but had no affinity to their release sites. It seems unlikely that a sex-specific kill occurred among the 1967 transplants. Recent studies by Vaught and Kirsch (1966) and Chapman et al. (1969) have shown no sex imbalance in the kill of juvenile Canada geese.

Breeding Behavior

Females.—During the springs of 1968 and 1969, 28 (80 percent) of the 35 homing yearling females formed observable pair bonds (Fig. 3). Nineteen (68 percent)

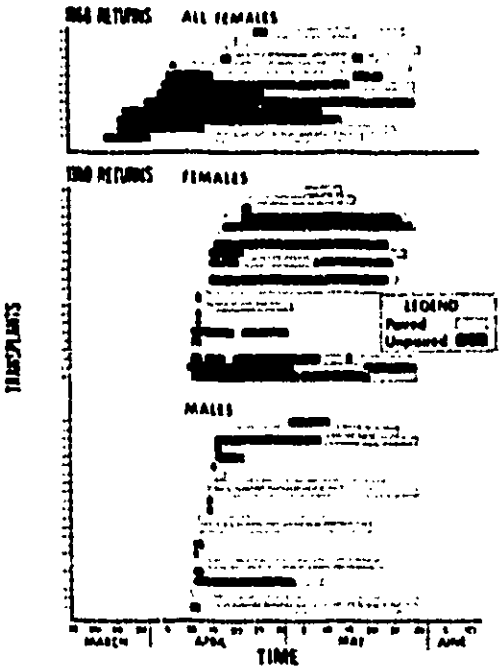

Fig. 3. Spring arrival and departure dates, and pair states of homing yearling geese on the study area.

of these pair formations were made on the study area. Because of access difficulties in the spring of 1969, it is my opinion that the number of pair formations on the study area was probably higher than recorded. When pairing activity is compared for each spring period, it is apparent that during the year of early arrival (1968), only 15 percent of the females arrived already paired. In the spring of 1969, when cold weather retarded the arrival of homing birds, 41 percent of the yearling females arrived in pair associations. Late arrivals in the spring of 1968 were either paired on arrival or were paired sooner than the earlier arriving geese in the same spring period. Naylor (1953), Balham (1954), and Hanson (1965) concluded that some pairing of yearling birds takes place on the breeding grounds.

In this study, 29 percent of the paired females became unpaired in the observational period (Fig. 3). There was a tendency for yearling females to either pair or become unpaired just prior to their molt migration. Six females exhibited pair associations within a week of their molt movement, while two females became unpaired during this same period. Balham (1954) observed unstable bonds among pairs involving yearling geese. Similarly, Sherwood (1967) found that just prior to their summer molt, the loyalty between paired yearlings began to decline. In this study, the instability of yearling pair bonds was also apparent. Three females from Study Lake 1 were each observed paired to two different marked yearling males.

Previous associations of juveniles on the breeding grounds may have influenced the choice of partners in some of the pair relationships observed among the yearling females. The transplants from Study Lakes 1 and 5 associated during the postflight period in the late summer of 1968. In the spring of 1969, seven of eight pair bonds involving females from Lake 1 or 5 involved males from the opposite lake. Klopman (1962) and Sherwood (1967) felt that early associations among Canada geese influenced future mate selection.

Fig. 3 indicates a tendency for females to remain attracted to their home lakes whether they were paired or unpaired. Of 23 females observed for 30 days or more on the study area, 10 (43 percent) were not paired after the 30-day period.

Brakhage (1965) reported that nonbreeding females were tolerated by resident breeding pairs. In my study, 12 observations were recorded of yearling nonbreeders closely associating with incubating adult females or newly hatched resident goslings. Only one instance of intolerance toward a yearling female was observed. On this occasion a territorial gander evicted a yearling when it approached within 5 ft of an incubating goose.

Twenty-three dominance displays were made by pairs involving yearling female transplants, 83 percent of which were on the release sites of the females making up the pairs. Social relationships exhibited by pairs that included yearling females were similar to those described for all age-classes by Hanson (1965) and Williams (1967). On all occasions, pairs that included yearling females were dominant over single birds but were subordinate to older breeding pairs. Dominance between pairs involving yearling females appeared to depend upon the size and aggressiveness of the respective ganders and also on the enthusiasm of the females involved.

During the spring observational period, a distinct relationship existed among: (1) the flock size in which a yearling female was found, (2) the pair status of the yearling birds involved, and (3) the phenology of the breeding season. In late March and early April, the yearling females arrived with large flocks of migrant birds. Following their arrival, they were observed associating with smaller groups of geese on or near their home lake. Once a pair bond was established, the two birds formed a separate unit, displaying intolerance to other birds in the area. All of the unpaired yearlings usually associated in small groups. Brakhage (1965) and Sherwood (1967) observed similar associations of single nonbreeding geese. Single and paired nonbreeding geese grouped into small flocks in preparation for their molt migration in late May. Although increased tolerance was exhibited by paired nonbreeders at this time, all pairs remained as sub-units within

the newly formed flocks. The exodus of nonbreeding geese from the study area was rapid. In 1968, 10 (77 percent) of the 13 homing female transplants left the study area between May 22 and May 31. Of 10 females that were known to remain on the area for over 30 days in 1969, all left the area between May 23 and May 30 inclusive. No yearling transplants were present on the study area after May 31 of both spring periods.

Males.—Of the 22 yearling males known to home to the study area in the spring of 1969, 15 (68 percent) showed pairing tendencies (Fig. 3). Four of the initial pair formations were known to occur on the study area. Comparable homing data were not obtained in the spring of 1968 due to the lack of homing yearling males at that time.

Only one yearling male was known to sever a pair relationship and remain unpaired while on the study area. However, unstable pair relationships were not uncommon with yearling males. Four males were each known to have been paired with two different marked females. In contrast to yearling female behavior, there was no marked tendency for yearling males to become paired or unpaired just prior to the molt migration (Fig. 3).

There was a strong indication that only paired yearling males remained on the study area for any duration. 7/1 of the nine males known to remain on the study area for 30 days or longer were paired (Fig. 3). Sherwood (1967:331) found "an obvious tendency for the male yearlings to disperse from their natal areas . . ." Assuming this to be true, it then appears that the attraction holding the males to this area was probably the females involved in the pair relationships rather than attraction to "pseudonatal" areas.

Two-Year-Old Homing and Breeding Activities

Females.—Five females were known to home to the study area as 2-year-old birds in the spring of 1969. These birds represented 38 percent of the 13 homing yearling females observed in 1968, and 7 percent of the 68 juvenile females transplanted in 1967. Two of the five females were birds that had been released as goslings on lakes unoccupied by resident geese.

Because of access difficulties in 1969, only one of the five females was initially sighted on its home lake. However, all of the birds were eventually observed on their release sites. All of the homing 2-year-olds were initially sighted from April 11 to April 17 inclusive.

Pairing activity by the 2-year-olds was apparently confined to the breeding grounds. Sherwood (1967) similarly found that the nesting ground was the location of all true pairing activity. Two of the five females were initially observed as single birds about 8 and 10 miles north of their respective home lakes. Within 4 days, both birds were sighted back on their respective release sites paired to unmarked ganders.

The other three females were each initially observed in a pair relationship with marked yearling males. Subsequent sightings of one of these birds indicated that she attempted to pair with two marked yearling males and one unmarked male within a 5-day period. Another of these 2-year-old females was observed paired to two marked yearling males over a period of 2 days.

From my observations it appeared that once the females arrived on the study area, there was a marked urge to seek out a suitable mate. The mate selection did not appear impulsive but, on the contrary, appeared as an evaluation process involving

a brief courting period followed by acceptance or rejection of the male. Rejection of males appeared to be correlated with their inability to exhibit "dominance" (Collias and Jahn 1959:482) in the face of rival males.

In this study, once the mate selection was made, all of the 2-year-old females attempted to establish a nesting territory on their respective release sites. All five pairs were evicted by unmarked pairs that subsequently nested on these areas. Once evicted, the paired transplants were never observed on their release sites for the duration of the breeding period. Only two of the five paired females were observed on the study area during this time.

From April 15, when the pair was evicted, until May 30, when they were last observed, one of the two remaining pairs stayed on Study Lake 1 located about 10 miles north of the female's home lake. This pair defended three specific areas on Lake 1 but no nesting attempt was made.

The other remaining pair established a nest on a small impoundment about 1.5 miles east of the female's 1967 release site. This pair successfully hatched and raised five goslings.

Craighead and Stockstad (1961:62) found between 27 and 36 percent of native wild *B. c. moffitti* 2-year-olds nesting in Montana. Brakhage (1965:750) and Sherwood (1967: 351), respectively, in their studies found 33 and 80 percent of the *B. c. maxima* 2-year-olds nesting. In this study, one of the five homing 2-year-olds was known to nest in the area. Although my data were limited, I feel a higher percentage of the 2-year-olds would have nested on the area had competition for nesting sites not been as great.

Males.—No 2-year-old males were known to home to the study area. The male observed passing through the study area on a molt movement as a yearling in 1968 was located about 60 miles south of its release site in the spring of 1969. This bird was paired to an unmarked incubating female. A single observation of another 2-year-old male was made at Dowling Lake about 35 miles northwest of its release site (E. Ewaschuck, personal communication). The breeding status of this bird was unknown.

DISCUSSION

The attachment of adult waterfowl to their nesting grounds, migration routes, and wintering grounds has been demonstrated in many studies (Williams and Kalmbach 1943, Sowls 1955, Bellrose 1959). Because of this homing behavior, the use of free-flying adults as transplants would defeat the purpose of such programs. For management purposes, only juvenile birds should be used for waterfowl transplant operations. In this study, 7- and 8-week-old goslings appeared to be a desirable age group to use for transplanting.

Canada geese have characteristically shown slow dispersion into new breeding areas, and in recent studies by Sherwood (1967), a strong attachment of female geese to their natal area was observed. By contrast, male Canada geese (Sherwood 1967) show less tendency to home to natal areas.

In this study, male homing was less specific than female homing and over the 2-year period, the return of males to the study area was significantly ($P < 0.05$) lower than that observed for females. Males appeared attracted to the females rather than to their release sites, therefore the use of male transplants would probably have little merit if the transplant sites were located on an area where spring migrations were known to exist. Female transplants homing to such an area would likely attract and hold males moving through the area. There-

fore, gosling transplant programs should lean heavily toward females when such programs are conducted in areas not isolated from normal goose movements.

The apparent influence of early associations on transplant pairing may warrant the use of males in areas isolated from migrational activity. In such situations, the fall associations of various cohorts or cohort fragments may influence homing males to remain on the area with some of the homing females. The effectiveness of male transplants under such circumstances deserves further investigation.

Although strong homing tendencies of yearling female waterfowl may inhibit the pioneering of new breeding habitat (Hochbaum 1955), this same behavioral trait could be used to an advantage in waterfowl management when applied to transplant programs. Most successful transplant programs have been those using species whose females exhibit a strong affinity to their natal area. Because yearling female Canada geese display this character, one would expect these birds to prove useful in transplant programs.

The transplant program attempted in this study verifies the homing and breeding of 2-year-old female Canada geese on or near the sites where they were released as goslings. These results indicate that the homing behavior of Canada geese is a learned process and is not innate in its origin. If the latter was affirmative, the geese involved would have homed to their true natal area. It appears that female Canada geese home to the specific site where they learn to fly as goslings.

The transplant release sites should be characterized by: (1) a permanent open-water body to serve as a secure gosling retreat from predators, and (2) an abundance of available vegetation that could be utilized as a food source by the transplants. A number of attractive nesting sites should be present to accommodate any potential breeding birds that home to the area.

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